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REPORT ON FORCED EMERGENCE OF OVERWINTERING SPRUCE BUDWORM LARVAE ON UNITS WITHIN THE PROPOSED 1958 OREGON CONTROL PROJECT

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Pacific Northwest
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R. W. Cowlin, Director — Portland, Oregon
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INTRODUCTION

The 1957 Region Six cooperative forest insect survey recorded 830,960 acres of epidemic spruce budworm infestations in the Blue Mountains of Oregon.[1/] These infestations are on or near the Malheur, Ochoco, Umatilla, and Wallowa-Whitman National Forests and are separated into the three areas below:

Area	Acres	Percent of infestation
Central Blue Mountains	710,800	85.6
Wallowa Mountains	101,600	12.2
Southwestern Blue Mountains	18,560	2.2
	830,960	100.0

On October 28, 1957, the Northwest Forest Pest Action Council recommended that the spruce budworm infestations in the Central Blue Mountains area be treated by aerial spraying in the spring of 1958.[2/] The proposed control project will comprise the 710,800 acres of the Central Blue Mountain epidemic infestations, and approximately 110,200 acres of lightly infested timber and buffer zones, giving a project total of about 821,000 acres.

An important step in planning spruce budworm control projects is the spring check to determine survival of the overwintering larvae. This check consists of obtaining sample collections of hibernating larvae from trees in the units scheduled for treatment and forcing emergence. This work has been completed for the 1958 project and the results are presented in this report.

1/ Whiteside, J. M., Important forest insect outbreaks in Oregon and Washington in 1957. Multilithed Report. December 1957.

2/ U. S. Forest Service and Oregon State Board of Forestry. Spruce budworm control plan for 1958 in the Pacific Northwest. Multilithed Report. April 1958. 12 pp., illus.

OBJECTIVES

The main objectives in forcing emergence of hibernating budworm larvae in the spring of 1958 are:

1. To determine whether natural mortality had reduced the hibernating population to a point where control measures would not be needed.

2. To determine whether limb or bole sections are better for sampling hibernating budworm populations.

METHODS

Collection procedures followed those of past years.[3/] [4/] The actual sampling was done on April 1, 2, 3, 15, and 16, at which time snow limited access to some prospective sampling points. All samples were taken from areas proposed for control (table 1).

The collectors drove as far as possible into the area to be sampled, and chose for sampling nearby trees that showed the heaviest degree of defoliation. Five trees with dbh of 12-24 inches, were selected and felled at each collection point. Fifteen limb sections, each 15 inches long, and a section of the bole approximately 15 inches long were selected and cut from each tree.

Since it is believed that the larvae prefer roughened bark areas for hibernation, the limb and bole sections were selected on that basis. Whenever rough bark was absent or scarce on the limbs of the felled tree, the limbs that had a large amount of lichens were selected. The collectors started sampling at the base of the crown and worked upwards, securing scattered limb-samples that had rough bark. The bole samples were cut at the point where bark texture passed from smooth to rough. A total of fifty trees were sampled at ten collection points.

3/ Wright, K. H. and A. Lindsten. Results of Experiments to Improve Techniques for Sampling Overwintering Spruce Budworm Populations in Oregon and Washington. Progress Report 1. May 20, 1952.

4/ Whiteside, J. M. and A. G. Gruba. Report on Emergence of Overwintering Spruce Budworm Larvae on Units Proposed for Spraying During the 1955 Oregon Spruce Budworm Control Project. Multilithed Report. April 15, 1955.

Figure 1.--Collector carrying bole and limb sections from collection point.

Figure 2.--Equipment used to collect limb and bole sections.

The sample collections were labelled in the field according to collection point, tree number, species of tree, and degree of budworm defoliation. The rating of defoliation was the same as on aerial surveys:

Light - slight feeding
Moderate - top 1/4 of crown fairly well defoliated
Heavy - 1/2 or more of crown defoliated

The collections were brought to the Sellwood Laboratory in Portland, placed in cardboard boxes, and sealed. Seventy boxes were placed in rearing on April 4, and thirty on April 17; giving a total of one hundred for the study (fig. 3). Fifty-two boxes contained white fir samples, forty-eight Douglas-fir, and two Engelmann spruce. Ten boxes constituted the sample of hibernating larvae for each collection point. By April 16 most of the larvae had emerged from the first set of boxes and that set was closed out. The second set of thirty boxes was closed out on April 30.

Figure 3.--Rearing boxes used to force emergence of hibernating spruce budworm larvae.

The larval emergence was recorded separately by tree and by collection point. Bark area was determined for each sample and the number of larvae computed per 100 square inches of bark area, for comparison of limb and bole samples. Since it was possible that sample trees showed more similarity in bole length and average unfoliated length of limbs, than in surface area of bole and average limb, a comparison of larval populations was also made on a strictly linear basis. In other words, a 15-inch bole was compared with 225 inches of limb.

Basic comparisons were on an individual tree basis, although summaries by collection point were also made. These comparisons were set up in a manner starting with the lowest and ending with the highest limb larval emergence figures from the rearing boxes. Limb and bole section emergence figures were paired for each tree.

RESULTS

The detailed findings are given in tables 1 to 4 in the appendix. The highlights follow.

A. Survival of overwintering populations.

The numbers of larvae obtained (table 1.) generally show adequate budworm population to justify the proposed control project. Comparison of last year's damage, as assessed by the observers, and expected populations feeding in the buds (from a table showing the relation between levels of hibernating population and larvae attacking the buds)[5/] indicates the following:

6 collection points - little change in population
1 collection point - higher populations than in 1957
3 collection points - lower populations than in 1957

Relatively small numbers of larvae emerged from the Cable Creek, Hello Boy Spring, and Fields Creek samples. The first two are in a small area of light reinfestation that the Northwest Forest Pest Action Council favors spraying while it is small. The Fields Creek sample, due to limited access, had to be taken in light infestation not typical of general conditions on the area.

5/ Carolin, V. M. 1950. Studies of the Biological control of the spruce budworm in Oregon - 1950. B.E.P.Q. Special Report - New Haven, Conn.

B. Comparison of budworm populations on limb and bole samples.

1. Bark area comparison.

Table 1 shows that on a collection point basis, the bole sections produced more larvae per 100 square inches of bark area than did limb sections in six of the 10 collection points. From the Dixie Summit collection point, the number of larvae emerging from bole sections is more than triple the number emerging from limb sections, and from the Sumpter Valley collecting point, the number is nearly triple.

The individual tree bark area comparison of limbs and boles is more sensitive than the collection point comparison because the two locations are paired on one tree, thereby eliminating variability between trees. In 23 out of the 50 trees sampled, more larvae emerged from boxes containing limbs than from boxes containing boles (table 2). The ratio was approximately 50-50. Therefore, there appears to be no significant difference between limb or bole sections, on an area basis, as to the sampling location which would indicate the maximum hibernating population.

2. Linear comparison.

A linear comparison shows that in 40 out of the 50 trees sampled, more larvae emerged from boxes containing limbs than from those containing boles (table 3). Since this ratio promised a significant difference between the two locations, a statistical analysis of the data was made for more evidence of this difference. A "t" test indicated with a high probability that there is a significant difference between the two locations.

An inspection of the linear comparison figures shows that the boxes containing limb-sections consistently, (with few exceptions out of 50 trees sampled) produced more larvae than did those containing bole-sections - especially in the heavily infested trees. Budworm emergence from bole-sections was much more erratic than emergence from the limb sections. Six trees had no budworm emerging from the bole-section samples at all.

After transformation of population estimates from the negative binomial to the normal distribution (tables 4, 5), a statistical analysis was performed using the null hypothesis: i.e., no difference between populations on limbs as compared with boles. The difference proves to be significant at $p = 0.001$ showing that, for the linear comparison, limb sections had significantly higher populations than bole sections.

On the basis of inspection and statistical analysis of the linear comparison data, limb section samples from infested trees should give a more reliable estimate of budworm populations in hibernation than bole samples.

CONCLUSIONS

The principal conclusions are:

1. The budworm population this spring warrants the proposed spraying.

2. Limb section samples give a more reliable estimate of budworm populations in hibernation than do bole section samples.

A P P E N D I X

Table 1.--Density of hibernating spruce budworm larvae on the bark of limbs and boles for trees at ten collecting points in eastern Oregon.

Control unit and collection point	Part of tree sampled	Boxes in rearing	Total larva emergence	Bark area sampled	Larval emergence per 100 sq. in. of bark area
		No.	No.	Sq.in.	No.
BAKER CONTROL UNIT					
Wetmore Camp					
(Moderate infestation)	Limbs	5	400	5,153	7.8
	Boles	5	98	1,313	7.5
All boxes		10	498	6,466	
Average (wtd.)					7.7
Dooley Mountain					
(Moderate infestation)	Limbs	5	992	4,639	21.4
	Boles	5	508	1,641	30.9
All boxes		10	1,500	6,280	
Average (wtd.)					23.8
Sumpter Valley					
(Light infestation)	Limbs	5	214	4,560	4.7
	Boles	5	203	1,510	13.4
All boxes		10	417	6,070	
Average (wtd.)					6.9
Cable Creek					
(Light to very light infestation)	Limbs	5	60	4,251	1.4
	Boles	5	7	1,950	.4
All boxes		10	67	6,201	
Average (wtd.)					1.1
Hello Boy Spring					
(Light to moderate infestation)	Limbs	5	143	5,090	2.8
	Boles	5	24	1,353	1.8
All boxes		10	167	6,443	
Average (wtd.)					2.6

Table 1.--(Continued)

Control unit and collection point	Part of tree sampled	Boxes in rearing	Total larva emergence	Bark area sampled	Larval emergence per 100 sq. in. of bark area
		No.	No.	Sq. In.	No.
JOHN DAY CONTROL UNIT					
Fields Creek (Light infestation)	Limbs	5	108	4,908	2.2
	Boles	5	35	1,492	2.3
All boxes		10	143	6,400	
Average (wtd.)					2.2
Vance Creek (Light to moderate infestation)	Limbs	5	250	5,030	5.0
	Boles	5	114	1,602	7.1
All boxes		10	364	6,632	
Average (wtd.)					5.5
Dixie Summit (Heavy)	Limbs	5	209	5,187	4.0
	Boles	5	287	1,629	17.6
All boxes		10	496	6,816	
Average (wtd.)					7.3
John Day River (Moderate infestation)	Limbs	5	130	5,256	2.5
	Boles	5	54	1,488	3.6
All boxes		10	184	6,744	
Average (wtd.)					2.7
Deardorff Creek (Moderate to heavy infestation)	Limbs	5	607	4,551	13.3
	Boles	5	125	1,466	8.5
All boxes		10	732	6,017	
Average (wtd.)					12.2

Table 2.--Limb and bole comparison of budworm emergence per 100 sq. in. of bark.

Locality	Tree number	Larvae per 100 sq.in. of bark: Limbs	Boles
		No.	No.
Cable Creek	2	.14	--
" "	4	.41	.46
" "	5	.44	--
John Day River	5	.72	1.08
Sumpter Valley	5	.77	.55
John Day River	1	.77	5.23
Hello Boy Spring	4	.89	--
John Day River	3	.93	--
Hello Boy Spring	5	1.00	1.70
Fields Creek	2	1.11	4.32
Dixie Summit	2	1.26	25.08
Vance Creek	1	1.47	2.66
Fields Creek	5	1.88	--
Wetmore Camp	2	1.99	18.39
Vance Creek	5	2.06	1.17
Hello Boy Spring	1	2.11	2.58
Cable Creek	3	2.38	.32
Fields Creek	4	2.48	1.74
" "	3	2.52	.75
Dixie Summit	4	2.64	17.35
Vance Creek	3	2.86	8.55
Fields Creek	1	2.97	4.34
Cable Creek	1	3.21	1.12
John Day River	2	3.75	1.09
Hello Boy Spring	3	3.97	.70
Sumpter Valley	4	4.35	15.03
" "	2	4.64	39.07
Dixie Summit	3	5.29	23.07
John Day River	4	5.66	9.19
Dixie Summit	5	5.81	15.09
Wetmore Camp	5	6.00	--
Hello Boy Spring	2	6.03	3.72
Dixie Summit	1	6.15	10.32
Dooley Mountain	5	6.47	57.14
Wetmore Camp	3	6.79	5.82
Sumpter Valley	3	7.05	5.87
Dooley Mountain	1	7.36	12.85
Vance Creek	2	8.03	17.06
Sumpter Valley	1	8.61	11.06
Deardorff Creek	5	9.75	17.92
" "	4	9.82	2.91
Wetmore Camp	4	10.58	13.65
Vance Creek	4	10.60	4.14
Wetmore Camp	1	10.63	4.21
Deardorff Creek	1	14.07	8.76
" "	2	14.85	12.87
Dooley Mountain	2	16.11	33.41
Deardorff Creek	3	19.02	2.04
Dooley Mountain	3	28.88	15.67
" "	4	49.55	41.60

Table 3.--Linear limb and bole comparisons of budworm emergence.

Locality	Tree number	Number of larvae	
		Limbs	Boles
Cable Creek	2	1	--
" "	5	3	--
" "	4	4	2
John Day River	5	7	4
" " "	1	7 6/	12
Hello Boy Spring	4	8	--
Sumpter Valley	5	9	2
John Day River	3	11 6/	--
Hello Boy Spring	5	11 6/	4
Fields Creek	2	11	9
Dixie Summit	2	15	52
Vance Creek	1	17	8
Wetmore Camp	2	17	40
Fields Creek	5	18	--
Vance Creek	5	19	4
Cable Creek	1	21 6/	4
Fields Creek	4	21	7
Hello Boy Spring	1	22	9
Fields Creek	3	27	2
Vance Creek	3	27	31
Cable Creek	3	31	1
Fields Creek	1	31	17
Dixie Summit	4	31 6/	70
Sumpter Valley	2	37	98
John Day River	2	39 6/	3
Sumpter Valley	4	41	62
Hello Boy Spring	3	42	2
Wetmore Camp	5	46	--
Dixie Summit	3	48 6/	77
" "	5	55	55
Sumpter Valley	1	58	27
Hello Boy Spring	2	60	9
Dixie Summit	1	60	33
Dooley Mountain	5	60 6/	138
John Day River	4	66	35
Wetmore Camp	3	67	13
Sumpter Valley	3	69	14
Dooley Mountain	1	69 6/	43
Vance Creek	2	83	61
Deardorff Creek	4	85	10
Vance Creek	4	104	10
Deardorff Creek	5	107	43
" "	1	108 6/	32
Wetmore Camp	4	109	33
Deardorff Creek	2	140	35
Dooley Mountain	2	158 6/	116
Wetmore Camp	1	161	12
Deardorff Creek	3	167	5
Dooley Mountain	3	258	53
" "	4	447	158

6/ One extra 15-inch limb section was found in each one of these boxes.

Table 4.--Conversion of linear limb budworm emergence figures, presumedly representing a negative biomial distribution, to those representing a normal distribution for normal statistic use.

Tree number	Limbs	Conversion $\sqrt{x+.5}$	Tree number	Limbs	Conversion $\sqrt{x+.5}$
1	1	$\sqrt{1.5} = 1.22$	36	67	$\sqrt{67.5} = 8.22$
2	3	$\sqrt{3.5} = 1.87$	37	69	$\sqrt{69.5} = 8.33$
3	4	$\sqrt{4.5} = 2.12$	38	69	$\sqrt{69.5} = 8.33$
4	7	$\sqrt{7.5} = 2.74$	39	83	$\sqrt{83.5} = 9.14$
5	7	$\sqrt{7.5} = 2.74$	40	85	$\sqrt{85.5} = 9.25$
6	8	$\sqrt{8.5} = 2.91$	41	104	$\sqrt{104.5} = 10.22$
7	9	$\sqrt{9.5} = 3.08$	42	107	$\sqrt{107.5} = 10.37$
8	11	$\sqrt{11.5} = 3.39$	43	108	$\sqrt{108.5} = 10.42$
9	11	$\sqrt{11.5} = 3.39$	44	109	$\sqrt{109.5} = 10.46$
10	11	$\sqrt{11.5} = 3.39$	45	140	$\sqrt{140.5} = 11.85$
11	15	$\sqrt{15.5} = 3.94$	46	158	$\sqrt{158.5} = 12.59$
12	17	$\sqrt{17.5} = 4.18$	47	161	$\sqrt{161.5} = 12.71$
13	17	$\sqrt{17.5} = 4.18$	48	167	$\sqrt{167.5} = 12.94$
14	18	$\sqrt{18.5} = 4.30$	49	258	$\sqrt{258.5} = 16.08$
15	19	$\sqrt{19.5} = 4.41$	50	447	$\sqrt{447.5} = 21.15$
16	21	$\sqrt{21.5} = 4.64$			
17	21	$\sqrt{21.5} = 4.64$			
18	22	$\sqrt{22.5} = 4.74$			
19	27	$\sqrt{27.5} = 5.24$			
20	27	$\sqrt{27.5} = 5.24$			
21	31	$\sqrt{31.5} = 5.61$			
22	31	$\sqrt{31.5} = 5.61$			
23	31	$\sqrt{31.5} = 5.61$			
24	37	$\sqrt{37.5} = 6.12$			
25	39	$\sqrt{39.5} = 6.28$			
26	41	$\sqrt{41.5} = 6.44$			
27	42	$\sqrt{42.5} = 6.52$			
28	46	$\sqrt{46.5} = 6.82$			
29	48	$\sqrt{48.5} = 6.96$			
30	55	$\sqrt{55.5} = 7.45$			
31	58	$\sqrt{58.5} = 7.65$			
32	60	$\sqrt{60.5} = 7.78$			
33	60	$\sqrt{60.5} = 7.78$			
34	60	$\sqrt{60.5} = 7.78$			
35	66	$\sqrt{66.5} = 8.15$			

Table 5.--Conversion of linear bole budworm emergence figures, presumedly representing a negative binomial distribution, to those representing a normal distribution for normal statistic use.

Tree number	Boles x_2	Conversion $\sqrt{x+.5}$	Tree number	Boles x_2	Conversion $\sqrt{x+.5}$
1	--	$\sqrt{.5}$ = .22	36	13	$\sqrt{13.5}$ = 3.67
2	--	$\sqrt{.5}$ = .22	37	14	$\sqrt{14.5}$ = 3.81
3	2	$\sqrt{2.5}$ = 1.58	38	43	$\sqrt{43.5}$ = 6.59
4	4	$\sqrt{4.5}$ = 2.12	39	61	$\sqrt{61.5}$ = 7.84
5	12	$\sqrt{}$ = 3.46	40	10	$\sqrt{10.5}$ = 3.24
6	--	$\sqrt{.5}$ = .22	41	10	$\sqrt{10.5}$ = 3.24
7	2	$\sqrt{2.5}$ = 1.58	42	43	$\sqrt{43.5}$ = 6.59
8	--	$\sqrt{.5}$ = .22	43	32	$\sqrt{32.5}$ = 5.70
9	4	$\sqrt{4.5}$ = 2.12	44	33	$\sqrt{33.5}$ = 5.79
10	9	$\sqrt{9.5}$ = 3.08	45	35	$\sqrt{35.5}$ = 5.79
11	52	$\sqrt{52.5}$ = 7.25	46	116	$\sqrt{116.5}$ = 10.79
12	8	$\sqrt{8.5}$ = 2.92	47	12	$\sqrt{12.5}$ = 3.46
13	40	$\sqrt{40.5}$ = 6.36	48	5	$\sqrt{5.5}$ = 2.34
14	--	$\sqrt{.5}$ = .22	49	53	$\sqrt{53.5}$ = 7.31
15	4	$\sqrt{4.5}$ = 2.12	50	158	$\sqrt{158.5}$ = 12.59
16	4	$\sqrt{4.5}$ = 2.12			
17	7	$\sqrt{7.5}$ = 2.74			
18	9	$\sqrt{9.5}$ = 3.08			
19	2	$\sqrt{2.5}$ = 1.58			
20	31	$\sqrt{31.5}$ = 5.61			
21	1	$\sqrt{1.5}$ = 1.22			
22	17	$\sqrt{17.5}$ = 4.18			
23	70	$\sqrt{70.5}$ = 8.39			
24	98	$\sqrt{98.5}$ = 9.92			
25	3	$\sqrt{3.5}$ = 1.87			
26	62	$\sqrt{62.5}$ = 7.91			
27	2	$\sqrt{}$ = 1.58			
28	--	$\sqrt{.5}$ = .22			
29	77	$\sqrt{77.5}$ = 8.80			
30	55	$\sqrt{55.5}$ = 7.95			
31	27	$\sqrt{27.5}$ = 5.24			
32	9	$\sqrt{9.5}$ = 3.08			
33	33	$\sqrt{33.5}$ = 5.79			
34	138	$\sqrt{138.5}$ = 11.76			
35	35	$\sqrt{35.5}$ = 5.79			